PROC. R. SOC. VICT. vol. 95, no. 4, 259-271, December 1983

PALAEOZOIC GEOLOGY OF THE DARTMOUTH DAM AREA, NORTHEASTERN VICTORIA

By P. F. Bolger,[1] H. R. Thorne,[2] P. D. Wood,[3] C. E. Cook,[4] and R. J. Rogerson[5]

[1] Herman Research Laboratory, State Electricity Commission, Howard Street, Richmond, Victoria 3121.
[2] State Rivers and Water Supply Commission, Orrong Road, Armadale, Victoria 3143.
[3] State Electricity Commission, William Street, Melbourne 3000.
[4] B.H.P. Whyalla, P.O. Box 21, Whyalla, South Australia 5600.
[5] Papua New Guinea Geological Survey, P.O. Box 778, Port Moresby, Papua New Guinea.

Abstract: The arcuate Wombat Creek Graben in the Dartmouth area of Northeastern Victoria is bounded on the east and west by Ordovician metasediments and localised areas of higher grade regional metamorphics and associated granitic rocks of the Omeo Metamorphic Complex. Acid to intermediate volcanic sequences, which are largely confined to the graben, were originally all included in the Mitta Mitta Volcanics but are now subdivided. The Silurian Mitta Mitta Volcanics consisting of dacite to rhyodacite are restricted to the southern part of the graben. In the north, a complex unit of dacite to rhyolite, named the Dartella Volcanic Group, is of possible Early Devonian age. Late Silurian clastic sediments comprising the Wombat Creek Group occur in the southern part of the graben. A number of Silurian to Devonian intrusives, some of which were intruded along faulted margins of the graben, range from quartz-diorite to muscovite granite. The volcanics of the Dartella Volcanic Group may be genetically related to some of these intrusions.

Filling of the reservoir of the Dartmouth Dam commenced in 1977 and much of the geological exposure in the Mitta Mitta River Valley upstream of the dam site has been lost to future workers. This paper is a summary of data collected during geological mapping by the authors between 1974 and 1978 and is intended to be an introductory description of the Palaeozoic geology of the flooded area and some of the surrounding district. It expands on regional mapping and detailed site investigations undertaken during construction of the Dartmouth Dam (S.R.W.S.C. 1980).

The area lies in the Eastern Highlands approximately 300 km northeast of Melbourne and is located to the east of the main Omeo Metamorphic Complex (Fig. 1). It is a zone of structural complexity which underwent intermittent igneous activity during the Silurian and the Devonian (VandenBerg 1978). Upper Cainozoic basalts and fluvial deposits occur within the area but are not described in this report. Rock samples collected are lodged at Monash University, the University of Sydney and with the Geological Survey of Victoria.

STRATIGRAPHY

Ordovician Metasediments

Pre-metamorphic Pile

Low grade metasediments form the bedrock surrounding the igneous and higher grade metamorphic complex at Dartmouth and the Wombat Creek Graben (VandenBerg *et al.* in press). The nature of the premetamorphic succession can only be determined by examination of low grade chlorite-quartz-white-mica (rarely biotite-bearing) slates, metasiltstones and metaquartzites. Even at low metamorphic grade, recrystallisation is well advanced and adjacent to large intrusions, medium and high grade schistose and hornfelsic metamorphic aureoles occur.

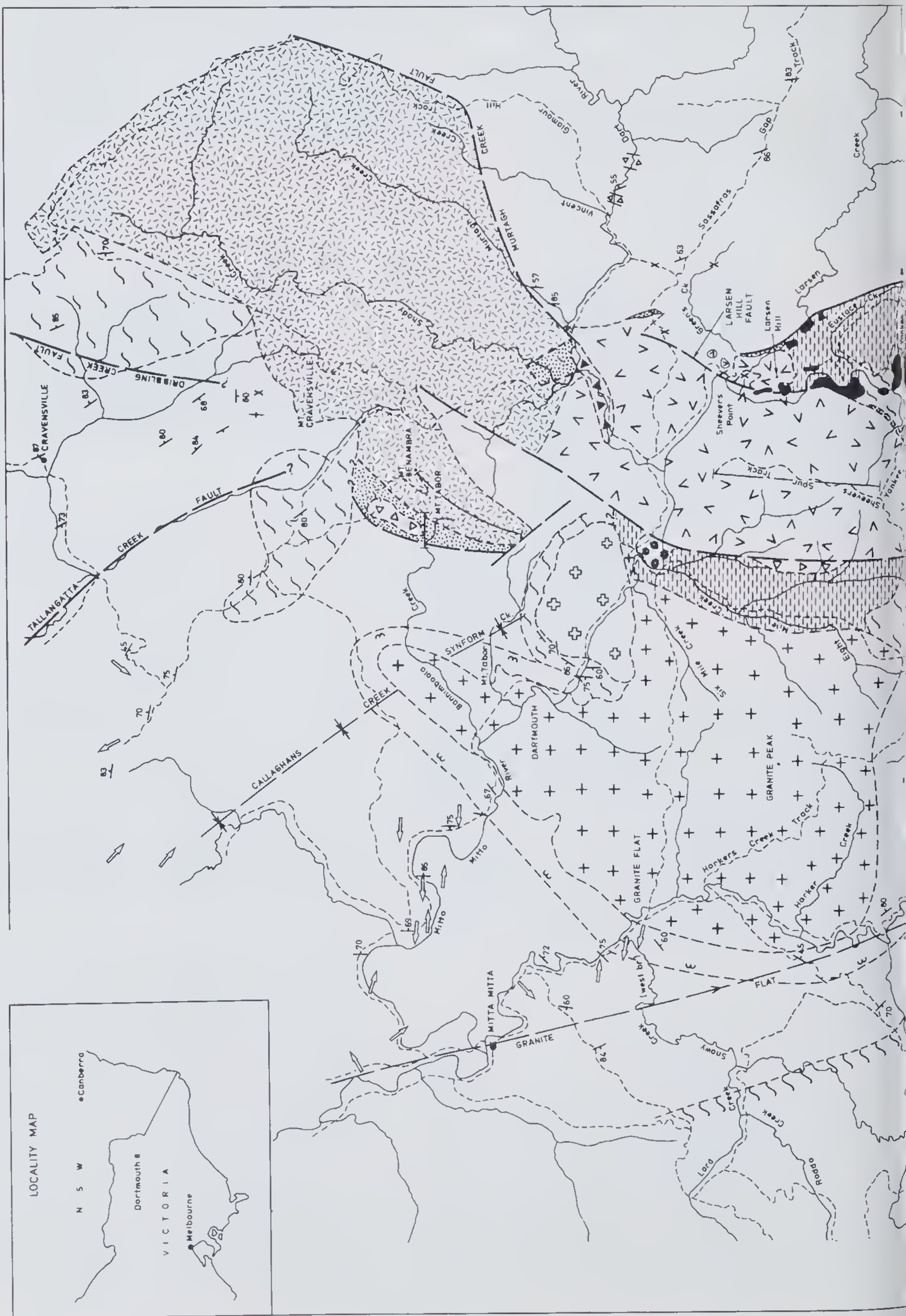
The Ordovician succession consists of an undetermined thickness of well bedded quartz-rich sandstone, siltstone, shale and thin rare cherts and siliceous limey beds. No basic igneous rocks of this age occur in the study area. Thick sandy beds are turbidites (Bolger 1982) displaying upward grading from coarse sandstone and siltstone to fine shaly layers having planar lamination, ripple drift cross-lamination and ripple marks. Load casts and flame structures are commonly developed. Sandstones are usually quartz-rich greywackes, with locally abundant detrital feldspar. Muscovite, tourmaline and zircon are also common detrital components. Shales are often laminated and discrete black shale (slate) units up to 30 m thick occasionally contain poorly preserved graptolites. The low-grade metasediments grade westwards into higher grade regional metamorphics in the Omeo Metamorphic Complex. Medium and high grade metamorphics also occur in the Dartmouth area.

Age

There are a number of widely spaced graptolite localities in low grade metasediments in the Dartmouth area. All contain Late Ordovician (usually Eastonian but occasionally Gisbornian or Bolindian) forms (Bolger 1978). In medium grade schists in the Eskdale area, early Bendigonian graptolites have been recovered (Kilpatrick & Fleming 1980). However, the relative scarcity of graptolite localities and the lack of marker horizons in this multi-deformed sequence, precludes definition of a regional younging direction.

Medium and High Grade Ordovician Metasediments

Along both the Dartmouth-Mt. Benambra Road and the Yankee Point Track, low-grade Ordovician metasediments grade into knotted phyllites, quartzites and schists. To the west of Mitta Mitta Township, they grade


LOCALITY MAP
N S W
Canberra
Dartmouth
VICTORIA
Melbourne
MURTAGH CREEK FAULT
DRIBBLING CREEK FAULT
TALLANGATTA CREEK FAULT
CALLAGHANS CREEK
GRANITE FLAT
LARSEN HILL FAULT
Larsen Hill
Sheevers Point
MT. CRAVENSVILLE
MT. BENAMBRA
MT. TABOR
CRAVENSVILLE
SYNFORM
DARTMOUTH
GRANITE PEAK
GRANITE FLAT
MITTA MITTA
Mitta Mitta River
Snowy Creek
Sassafras
Vincent
Six Mile Creek
Harkers Creek Track
Bannimboola

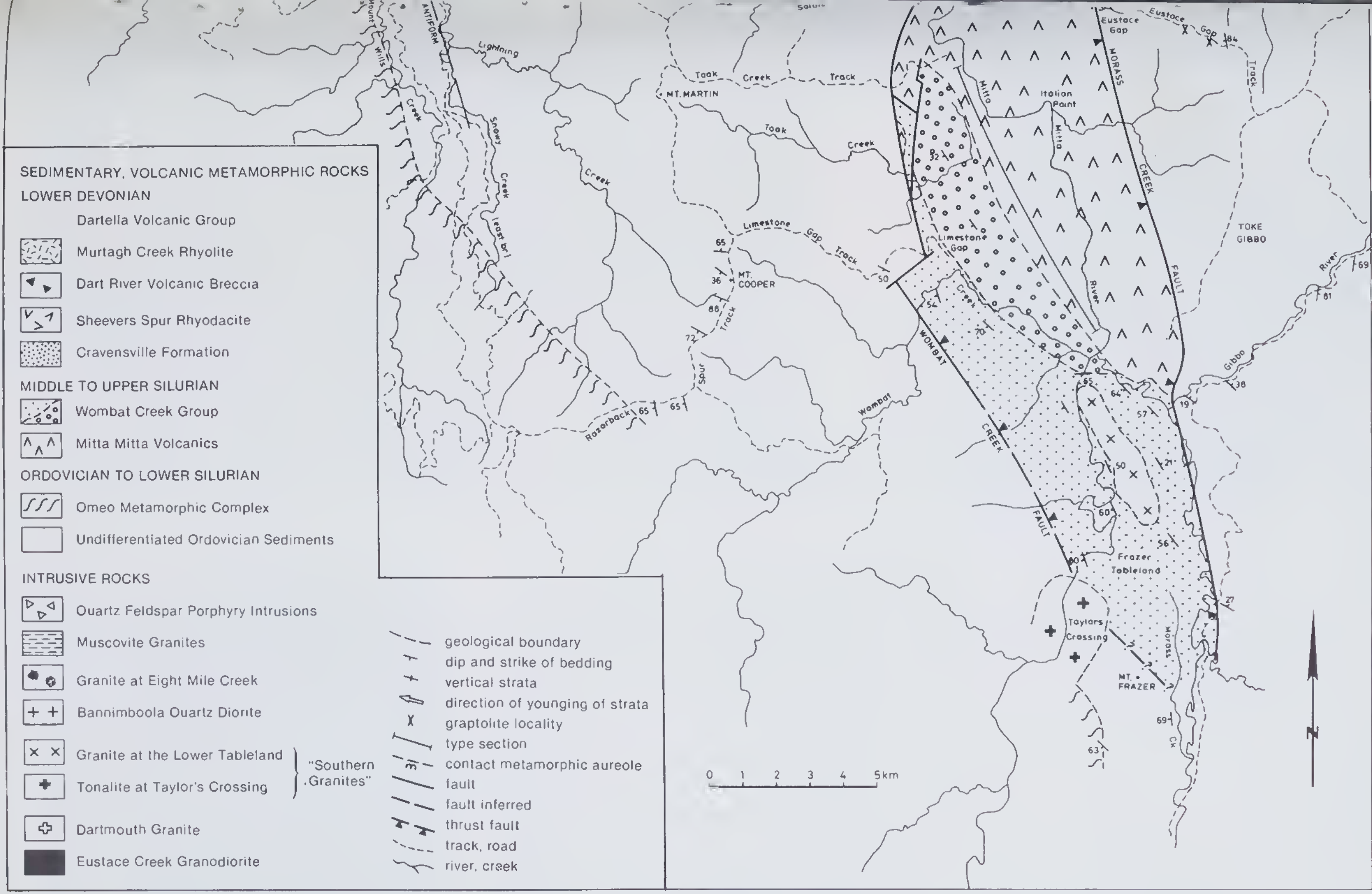


Fig. 1—Geological Map of the Dartmouth Dam Area.

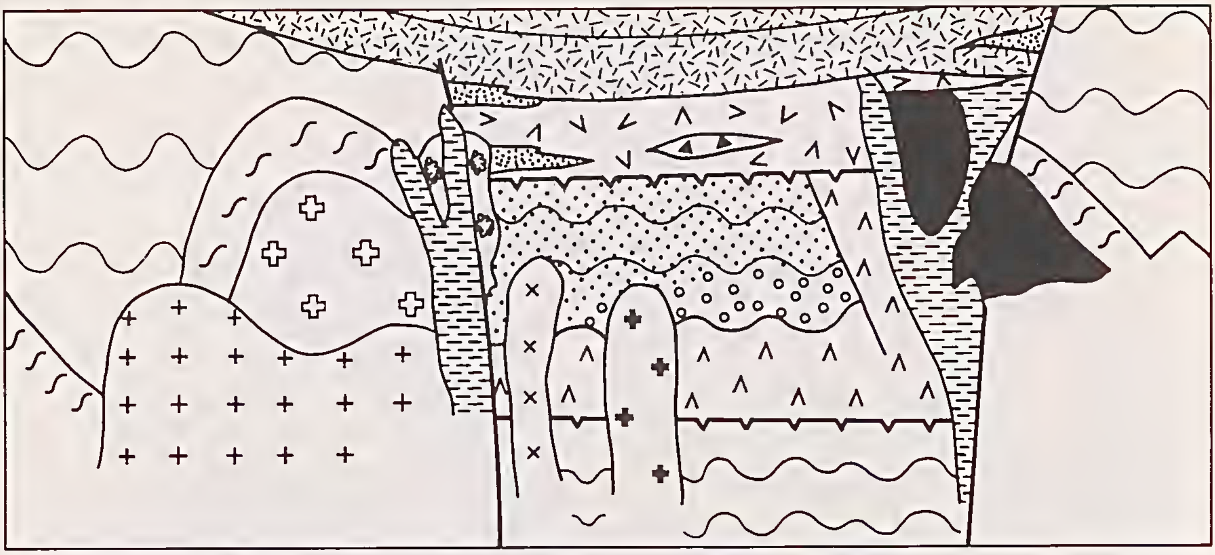


Fig. 2—Rock relation diagram for the Wombat Creek Graben. (Symbols as for Fig. 1).

into phyllites and schists of the Omeo Metamorphic Complex. The increase in metamorphic grade is marked by the appearance and increase in grain size of cordierite and/or andalusite porphyroblasts. In road cuttings along the Dartmouth-Mt. Benambra Road, the lowest grade rocks are knotted phyllites comprising pinitized cordierite porphyroblasts up to 1.5 cm long within a strongly foliated quartz-muscovite-biotite matrix. At higher metamorphic grade approaching the Dartmouth Granite boundary, crenulated muscovite-biotite-quartz knotted schists with large cordierite and/or andalusite porphyroblasts grade into higher grade sillimanite-bearing banded schists and gneisses adjacent to the granite. On the Yankee Point Track, knotted phyllites with coarse cordierite and/or andalusite porphyroblasts, grade into quartzite and biotite schist near the contact with the Eustace Creek Granodiorite.

Silurian

Mitta Mitta Volcanics

A linear belt of dacite, rhyodacite, rhyolite and volcanic breccia extends from the junction of the Gibbo and Mitta Mitta Rivers as far north as Cravensville. This suite was collectively named the Mitta Mitta Volcanics by Talent (1959) and was later referred to by Talent (1965), Singleton (1965) and Talent *et al.* (1975). They were mapped but not differentiated by Bolger and King (1976). Subsequent mapping and petrographic examination has shown that the rocks in this belt comprise three volcanic and one partly sedimentary unit representing at least two different volcanic episodes within the area. The Mitta Mitta Volcanics are here restricted to the southernmost suite of dacite and rhyodacite which outcrops from south of Yankee Point to the confluence of the Mitta Mitta and Gibbo Rivers (Bolger 1982). The volcanic rocks north of Yankee Point towards Mount Cravensville are herein called the Dartella Volcanic Group.

The best exposures of Mitta Mitta Volcanics were along the Mitta Mitta River. The following discussion of the unit is based on observations made in the section along the river which would have been the logical type section had it not been inundated. The only other accessible area of exposure is along the main ridge south of Eustace Gap between the Mitta Mitta River and the Toke Gibbo Track and this is proposed as a type area for the Mitta Mitta Volcanics (Bolger 1982) (between G.R. 555388 and 588327 Benambra 1:100 000 topographic map). Outcrops of the Mitta Mitta Volcanics are massive, forming steep bluffs overlooking the Gibbo River and large rapids on the Mitta Mitta River. Apart from a thin tuff band and occasional columnar jointed units (Fig. 3), the Mitta Mitta Volcanics are mesoscopically structureless. In outcrop, the rocks are generally green-grey, purple-brown and white with sparse fine grained phenocrysts. At the Mitta Mitta-Gibbo River junction, near the contact with the Wombat Creek Group, there are occasional pyrite cubes. The rocks contain bipyramidal embayed quartz phenocrysts, prismatic and zoned plagioclase, rare potash-feldspar and some altered biotite (Fig. 4). Xenoliths are rare to absent. The groundmass is highly chloritic. Primary ignimbritic textures were recognised in only one sample which contained undistorted, devitrified glass shards. Spherulites are abundant, perlitic cracks are common (I. A. Nicholls *pers. comm.* 1979) and there are occasional cavities lined with chalcedonic silica.

Brecciated volcanics (? flow breccias) consisting of clasts of acid volcanics up to 20 cm diameter in a fine grained green chloritic matrix outcrop along the Mitta Mitta River at a number of localities.

The Mitta Mitta Volcanics are considered to postdate the Ordovician beds and are faulted against them

Fig. 3—Columnar joints in southerly dipping Mitta Mitta Volcanics, Mitta Mitta River, 1 km north of Gibbo River junction.

Volcanics are overlain by the Upper Silurian Wombat Creek Group which contains acid volcanic detritus derived from the Mitta Mitta Volcanics in its basal conglomerate (Singleton 1965, Bolger 1982). The Mitta Mitta Volcanics are therefore post-Late Ordovician in age and may be as young as Wenlockian (Middle Silurian). They are possibly time equivalents of the Douro Group of the Yass area in New South Wales (Pogson & Baker 1974) and are probably equivalent to the Thorkidaan Volcanic Group east of Benambra (VandenBerg *et al.* in press).

Wombat Creek Group

The Wombat Creek Group is exposed from Toaks Creek southward to near Taylors Crossing. The best exposures were in the river sections now inundated by the reservoir. There is a small outlier in the Benambra area along Morass Creek. The Wombat Creek Group is in excess of 3800 m thick and consists of three formations—the Toaks Creek Conglomerate, the Gibbo River Siltstone and the Tongaro Sandstone, which have been described in detail and discussed elsewhere (Bolger 1982).

The Toaks Creek Conglomerate consists of massive grain-supported conglomerate containing well rounded clasts up to 35 cm in diameter, underlain by a thin basal unit of green-grey siltstone, feldspathic sandstone and pebbly sandstone. Clasts consist of quartzite and quartzitic sandstone, chert, acid volcanics derived from the underlying Mitta Mitta Volcanics, siltstone, minor granite and reef quartz. Towards the top of the Conglomerate along the Mitta Mitta River, recrystallised limestone clasts occur.

The Toaks Creek Conglomerate is overlain by the Gibbo River Siltstone consisting of bioturbated fossiliferous brown and green siltstone with interbedded quartz sandstone, conglomerate and lenticular limestones near the base. The conglomerates contain quartzite and granitic clasts. Shelly fossils in the siltstones and limestones include corals and brachiopods which indicate a Late Silurian (Ludlow) age (Talent 1959, 1965, Talent *et al.* 1975).

The uppermost unit of the Wombat Creek Group, the Tongaro Sandstone, consists of well-bedded fine to medium grained turbiditic quartz sandstone and interbedded black siltstone. In the southern part of the belt, there are interbedded limestones which contain shelly fossils (Talent 1959, 1965, Talent *et al.* 1975) and conodonts (Cooper 1977), suggesting a Late Silurian age. In the northwest near Wombat Creek, the Tongaro Sandstone contains massive conglomerates consisting entirely of well-rounded quartzite clasts. The top of the sequence is faulted against the Ordovician by the Wombat Creek Fault which is exposed along the Limestone Gap Track. The Wombat Creek Group overlies the Mitta Mitta Volcanics, although structural complexity at the contact has masked stratigraphic relationships between the two units. Along the Mitta Mitta River, the volcanics dip southwesterly beneath the Wombat Creek Group, except in a highly complex zone at the contact. In this zone, the sequence is overturned so the volcanics appear to overlie sediments which are faulted, folded, overturned and have a pronounced fracture cleavage. Along the Gibbo River, the volcanics have been thrust over the Wombat Creek Group giving the false appearance of an unconformity, with the volcanics appearing to post-date the sediments.

DEVONIAN

Dartella Volcanic Group (Named after the Parish of Dartella)

Introduction: The Dartella Volcanic Group is a new name introduced to include an intermediate to acid volcanic suite extending from Yankee Point to the

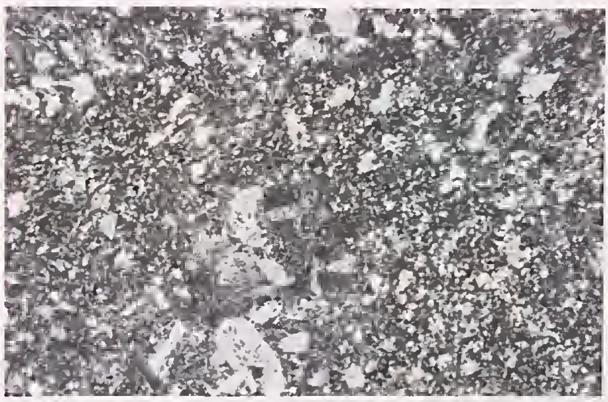


Fig. 4—Photomicrograph of altered dacite showing fine grained spherulitic groundmass, Mitta Mitta Volcanics. Aggregate at top centre consists of plagioclase, chlorite and minor epidote. (×30)

Fig. 5—Eutaxitic texture in rhyodacitic lapilli tuff, Sheevers Spur Rhyodacite, Mitta Mitta River near Larsen Creek Junction.

Lightwood area, north-east of Cravensville. The Group comprises the Cravensville Formation, Sheevers Spur Rhyodacite and the Murtagh Creek Rhyolite. These units were originally included in the Early Silurian Mitta Mitta Volcanics (Talent 1959, 1965, Talent *et al.* 1975, Singleton 1965, Bolger & King 1976, Bolger & Rogerson 1978a) but on structural and petrographic grounds, are now considered to be a separate Group, possibly of Early Devonian age. The volcanics of the Dartella Volcanic Group are petrographically distinct from the Mitta Mitta Volcanics and are much less altered.

Cravensville Formation (Named after Mount Cravensville): The Cravensville Formation is a sequence of interbedded black siltstone, tuffaceous sandstone and breccia and thin ignimbritic units. It is best exposed on a spur trending west from Mount Benambra (between G.R. 505592 and 492595, Benambra 1:100 000) and this is designated as the type section. Small outcrops of slate breccia, volcanics, quartzites and slate referred to the Cravensville Formation occur on the spur between Green and Larsen Creeks, the Sassafras Gap Track, the Dart River and the Yankee Point Track. A small exposure of gently dipping sediments near Shady Creek is tentatively included in the Cravensville Formation.

Sedimentary breccias are characteristic of the Cravensville Formation, consist of tightly packed, angular slate clasts up to 5 cm in diameter, and are often silicified. Sandstones (quartzites) contain abundant metamorphic quartz, plagioclase, alkali feldspar, tourmaline and brown hornblende. Interbedded volcanic units are thin and perhaps in places reworked, although along the spur between Greens and Larsen Creeks, eutaxitic texture typical of the Sheevers Spur Rhyodacite occurs. Black siltstones and tuffaceous sandstones often have a poorly developed cleavage. The Cravensville Formation is always exposed at or near the margins of the volcanic units. It is considered to represent material accumulated at the margins of the Graben prior to or during major volcanic episodes. It is associated with volcanic units from the top to the bottom of the Dartella Volcanic Group and is thus considered to be diachronous. The steep dips and cleavage in parts of the Cravensville Formation, compared with the relatively gentle dips of the volcanic units, are attributed to movement on nearby faults and the more ductile response to deformation of the sedimentary rocks.

Sheevers Spur Rhyodacite (Named after Sheevers Spur, Mitta Mitta River): Ignimbritic rhyodacite and dacite with subordinate andesite and rhyolite form the southernmost unit of the Dartella Volcanic Group and are collectively named the Sheevers Spur Rhyodacite. As with the Mitta Mitta Volcanics, the best exposures were along the Mitta Mitta River but are now inundated. The designated type area is west of the Mitta Mitta River along the Sheevers Spur Track between G.R. 517503 and 513453.

The unit is variable in composition, grain size and xenolith composition. Eutaxitic texture (Fig. 5) is well developed in welded volcaniclastics demonstrating that the Sheevers Spur Rhyodacite is ignimbritic. Rocks of this suite contain up to 20% phenocrysts and varying amounts of flattened pumice or clastic fragments. They are distinguished from the Mitta Mitta Volcanics and the Murtagh Creek Rhyolite by the abundance of pyroxene phenocrysts and igneous rock fragments.

Feldspars are the most abundant phenocrysts and are always altered. Plagioclase is mostly andesine in the rhyodacites but as calcic as labradorite in the dacites. Some plagioclase is zoned with extensively altered cores. Alkali-feldspar, when present, is greatly subordinate to plagioclase. Quartz occupies only 3 to 5% of the rocks and is typically found as embayed, cracked hexagonal grains. Chloritised (?) pyroxenes are ubiquitous and occur as prismatic blocky grains. Biotite is present but not common. Inclusions of slate, sandstone and flattened pumice are common to abundant. Granitic and acid volcanic clasts of variable size and abundance are ubiquitous. The groundmass is fine grained, quartzo-feldspathic and highly chloritic. Spherulites are present. No cuspate, undevitrified glass shards are preserved but there is a pronounced banding around phenocrysts and clasts, suggesting original eutaxitic layering.

Fig. 6—Concentration of granitic, and subordinate volcanic and sedimentary clasts in fine grained groundmass; Dart River Volcanic Breccia, Dart River.

In the Dart River area, dacitic to andesitic rocks containing large, often twinned augite phenocrysts in a very fine grained quartzo-feldspathic groundmass and a minor occurrence of rhyolite with abundant quartz in a devitrified groundmass are included in the Sheevers Spur Rhyodacite.

Within the Sheevers Spur Rhyodacite, outcropping in the Dart River between G.R. 625538 and 552549 is a complex unit here named the Dart River Volcanic Breccia containing lithic clasts usually up to 30 cm in diameter but some up to 1 m. Clasts are mainly igneous (Fig. 6) and consist of Sheevers Spur Rhyodacite and granite, as well as sandstone, slate and rare pegmatite. It has a fine-grained quartzo-feldspathic groundmass. The Dart River Volcanic Breccia passes into a rhyolite of the Sheevers Spur Rhyodacite on the northern side of the Dart River and is gradational with rhyodacites, dacites and andesites to the south and west. Its stratigraphic position within the Sheevers Spur Rhyodacite is not clear.

Murtagh Creek Rhyolite (Named after Murtagh Creek): A unit of ignimbritic rhyolite, rhyodacite and agglomerate outcrops on the Mount Benambra-Dartmouth Road and extends as far north as the Lightwood Track, north-east of Cravensville. It is here named the Murtagh Creek Rhyolite and the type section is the section exposed along the Dartmouth-Mount Benambra Road (G.R. 500560 and 513596). The rocks are often deeply weathered although locally they form steep bluffs and high peaks such as Mounts Benambra and Cravensville. A massive siltstone is exposed at the base of the sequence near Tallangatta Creek. When fresh, the Murtagh Creek Rhyolite is generally strongly welded, dense, grey to grey black in colour with euhedral quartz, pink and white feldspar phenocrysts, flattened pumice fragments and slate clasts in a quartzo-feldspathic groundmass (Fig. 7). In northern outcrops, the rocks are usually deeply weathered and usually white in colour. Slate clasts are common and vary in abundance throughout the Murtagh Creek Rhyolite. Clasts form less than 2% on the Dart River-Mount Benambra Road and increase with elevation to 30-50% north of Mount Tabor. On Mount Benambra, randomly oriented blocks

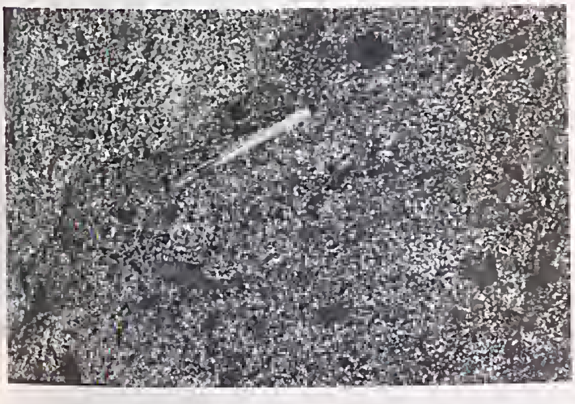


Fig. 7—Murtagh Creek Rhyolite consisting of quartz and feldspar phenocrysts and clasts of black slate, Mt. Benambra Road.

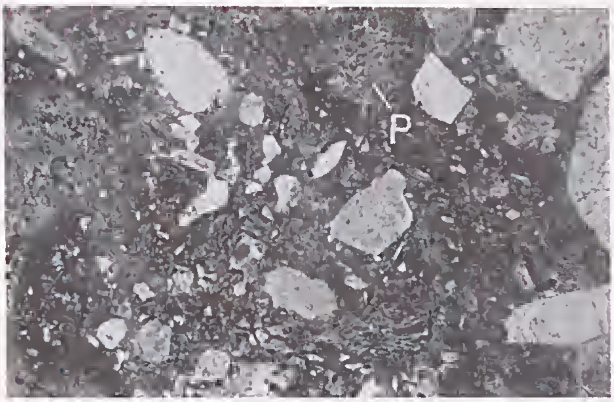


Fig. 8—Rhyodacitic tuff with shard texture and uncompacted pumice fragments (P), Murtagh Creek Rhyolite. (×30)

of slate and interbedded slate and slate breccia up to 3 m in length occur.

Phenocrysts occupying up to 35% of the rock are mostly bipyramidal and embayed quartz, alkali feldspar and plagioclase, chloritised biotite and small amounts of hornblende. Potash-feldspar is usually more abundant than plagioclase. The groundmass usually displays recognisable devitrified glass shards (Fig. 8) which are often distorted around phenocrysts and clasts. Spherulites occur in isolated pockets and post-date distortion of the shards. Some sections show recrystallisation to a fine grained quartz-feldspathic groundmass which is occasionally chloritic and rarely contains axiolites. Highly cleaved clasts of slate, one piece of "graphitic" slate and occasional quartz sandstone form clasts observed in thin section. One floater of andesite containing euhedral pyroxene phenocrysts in a very fine grained black groundmass was found at Mount Cravensville but its source bed was not located. A thin basaltic unit is exposed in a road cutting near the summit of Mount Benambra. No other basic to intermediate volcanic rocks were found in the Murtagh Creek Rhyolite.

Boundary Relations: The Sheevers Spur Rhyodacite has a complex, faulted eastern boundary against Ordovician metasediments and the Cravensville Formation. The western boundary along the Mitta Mitta River near Eight Mile Creek is intruded by a coarse-grained granite. A complex linear belt approximately 500 m wide along the eastern side of the Mitta Mitta River is exposed along the road between Sheevers Point and Larsen Hill. The Sheevers Spur Rhyodacite here contains a large number of randomly oriented blocks of slate, some greater than 10 m wide (containing Late Ordovician graptolites at three localities), sandstone and knotted phyllite set in a volcanic matrix similar to the rhyodacites of the Sheevers Spur Rhyodacite. It is considered to be a brecciated phase of the Sheevers Spur Rhyodacite but differs from the Dart River Volcanic Breccia in its predominance of metasediment blocks over igneous material.

Talent (1965) stated that the volcanics near Larsen Hill post-date the Bannimboola Diorite because of the

presence of "house-sized blocks" of diorite included in the volcanics. However, these exposures are outcrops of foliated granodiorite, suggested to be a biotite bearing phase of the Eustace Creek Granodiorite, not Bannimboola Quartz-Diorite. There is no conclusive evidence that they are allochthonous blocks. Thin veins of volcanics intrude the granodiorite and there are blocks of biotite granite in the volcanics. The Sheevers Spur Rhyodacite may rest on an irregular erosion surface of the Eustace Creek Granite. The contact is now complicated by faulting.

The relationship between the Bannimboola Quartz-Diorite and the Sheevers Spur Rhyodacite is not clearly established as there are no positively recognised clasts of diorite in the rhyodacite. However, the granite which intrudes the volcanics on the Mitta Mitta River near Eight Mile Creek may be a marginal phase of the Bannimboola Quartz-Diorite, suggesting that the volcanics predate the intrusion. The Sheevers Spur Rhyodacite is itself intruded by a quartz-muscovite granite near the junction of Larsens Creek and the Mitta Mitta River and at Larsen Hill.

In the southern outcrops of the Dartella Volcanic Group, there appears to be a gradation from the Sheevers Spur Rhyodacite into the Murtagh Creek Rhyolite, implying a vertical gradation from a more intermediate to more acid sequence. In the northern areas of outcrop, Murtagh Creek Rhyolite unconformably overlies Ordovician slate and higher grade metamorphic rocks and in the Cravensville area the contact appears to be flat lying.

In the headwaters of Murtagh Creek, there are abundant floaters of massive quartzitic sandstone and brown siltstone associated with the Murtagh Creek Rhyolite. Outcrops in this area are poor and it is not known whether the sediments are sedimentary clasts weathered out of the volcanics, are interbedded with the volcanics, or are incorporated into a series of fault slivers aligned parallel to the eastern boundary of the volcanics. There is a large belt of Ordovician metasediments south of Mount Benambra.

Age: The Dartella Volcanic Group post-dates the Benambran Deformation as it contains clasts of sedimentary, igneous and metamorphic rocks deformed by or produced during this event. The Murtagh Creek Rhyolite is petrographically similar and has similar structural attitude to the Early Devonian Snowy River Volcanics described from southeast of Dartmouth by Ringwood (1955) and the Jemba Rhyolite (Edwards & Easton 1938, Birch 1978) from near Corryong, which has been Rb/Sr dated at 400 ± 8 m.y. (Brooks & Leggo 1972, recalculated by Richards & Singleton 1981). Although there is no certainty that volcanism was contemporaneous in all areas, it is noteworthy that extensive acid volcanism took place in eastern Victoria in the Early Devonian. On this basis it is suggested that the Murtagh Creek Rhyolite may also be of Early Devonian age. The apparent gradation from the Sheevers Spur Rhyodacite to the Murtagh Creek Rhyolite implies that the Sheevers Spur Rhyodacite is also Early Devonian in age.

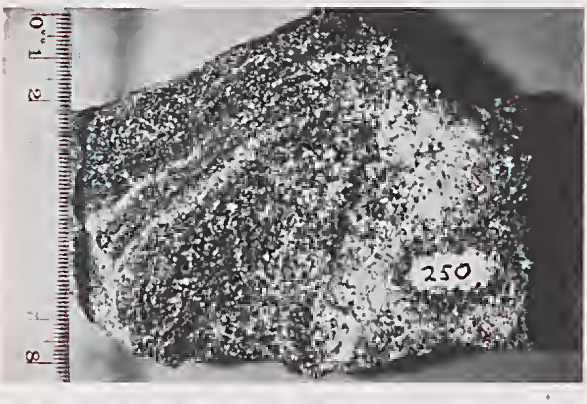


Fig. 9 – Foliated and non-foliated components of the Dartmouth Granite.

INTRUSIVE ROCKS

Dartmouth Granite

Field Character

The Dartmouth Granite is a grey two-mica granite exposed over 11 km² in and around the Dartmouth Dam. It is heterogeneous in texture consisting of medium to coarse grained foliated and non-foliated components (Fig. 9). The foliation is defined by alternating layers of K-feldspar and biotite rich bands.

Xenoliths and biotite-rich schlieren are common throughout the intrusion. Xenoliths are always metasedimentary with two common types. Most common are schistose biotite-quartz-muscovite-potash feldspar-sillimanite ($\pm$cordierite) xenoliths of pelitic parentage but there are also large (up to 1 m) ovoid quartz-plagioclase-clinopyroxene ($\pm$actinolite$\pm$garnet) types which probably represent the quartz-rich limey facies mentioned above. The trend of the foliation and orientation of xenoliths in the Granite parallels the trend of bedding in the enveloping metamorphic rocks, which may imply a close relationship between deformation and intrusion. The northern, western and eastern granite margins are relatively straight, suggesting steep boundaries in those areas. A schistose aureole extends 1.5 km north of the intrusion. Along its southern boundary, it is intruded by the Bannimboola Quartz-diorite (see below), a chemically and petrographically distinct pluton. At least two diorite dykes intrude the Dartmouth Granite just west of the dam. Intrusion of the Bannimboola has locally hornfelsed the previously schistose metamorphics surrounding the Dartmouth mass where the two intrusions are adjacent. Rogerson (1979) has described metamorphic textures imposed on the Dartmouth Granite adjacent to the Bannimboola intrusion.

Mineralogy and Chemistry

Modal analyses indicate approximately 30% quartz, 30% orthoclase, 15% plagioclase, variable (8%-24%) biotite, 3% muscovite and variable accessories (3%). Accessories include cordierite, sillimanite (fibrolite), apatite and zircon. Within 100 m of its boundary with the Bannimboola Quartz-Diorite, the Dartmouth Granite shows sericitised potash feldspar anhedra, biotite altered to chlorite and magnetite and extensive

fibrolite nucleation on biotite. Only one chemical analysis has been carried out on the intrusion (Table 1).

TABLE 1
CHEMICAL ANALYSIS AND CIPW NORM OF DARTMOUTH GRANITE

SiO_2	72.11	Quartz	44.21
Al_2O_3	14.42	Orthoclase	21.41
Fe_2O_3	0.97	Albite	12.83
FeO	3.19	Anorthite	1.95
MnO	0.04	Corundum	7.28
MgO	1.52	Hypersthene	8.00
CaO	0.56	Magnetite	1.41
Na_2O	1.52	Ilmenite	1.06
K_2O	3.62	Apatite	0.30
H_2O^+	1.66		
H_2O^-	0.26		
TiO_2	0.56		
P_2O_5	0.13	Anal. R. Rogerson	
	100.56		

The analysis shows low CaO typical of *S-type* granites (Chappell & White 1974) and relatively high SiO_2 and Al_2O_3.

Age: The Dartmouth Granite pre-dates intrusion of the Bannimboola Quartz-Diorite. Similar granites with schistose aureoles comprising parts of the Corryong Batholith further north have Rb/Sr ages of 421 ± 8 m.y. (Brooks & Leggo 1972, recalculated by Richards & Singleton 1981). The Dartmouth Granite is considered on regional grounds to be of Early Silurian age.

EUSTACE CREEK GRANODIORITE

The Eustace Creek Granodiorite was exposed along the Mitta Mitta River prior to inundation by the Dartmouth Dam. It has been regarded as an eastern phase of the Bannimboola Quartz-Diorite (Talent 1965, Singleton 1965, Modrich 1973) but recent work suggests that it is an older, multi-phase intrusion which is being deroofed at present. A foliated, medium-grained deformed quartz-diorite consisting of quartz and plagioclase, abundant fragmented green hornblende and kinked chlorite (probably after biotite) outcrops on the Mitta Mitta River near the mouth of Eustace Creek. The rock is intersected by veins of (?) epidote and there is extensive plagioclase alteration. Granitic rocks outcropping along Larsen Creek and exposed in road cuttings near Larsen Hill are also included in the Eustace Creek Granodiorite. At Larsen Hill, there is a coarse grained foliated granodiorite containing quartz, plagioclase, minor potash feldspar, chloritised biotite and highly altered hornblende. In contrast to the outcrop at the mouth of Eustace Creek, biotite is the major mafic mineral in the Larsen Hill exposure. Gradations between the two rock types described above, including some unfoliated phases, outcrop along the Mitta Mitta River north of Eustace Creek. No xenoliths have been observed.

The Eustace Creek Granodiorite intrudes Ordovician metasediments along the Mitta Mitta River, where the top of the intrusion is exposed in cliffs. In the complex brecciated zone in the Sheever Spur Rhyodacite, thin veins of volcanics similar to the Sheevers Spur Rhyodacite penetrate the Granodiorite. If the suggested Early Devonian age of the volcanics is correct, the Eustace Creek Granodiorite must be older than Devonian.

A K/Ar date of 440 ± 9 m.y. has been obtained for hornblende from an outcrop on the Mitta Mitta River (Richards & Singleton 1981). Another K/Ar date of 388 ± 8 m.y. was obtained by AMDEL using specimens from the same outcrop. However, the hornblendes used in the latter case contained carbonate. The older date of 440 ± 9 m.y. may therefore be more reliable and suggests an Early Silurian age for the Eustace Creek Granodiorite.

SOUTHERN GRANITES

Two intrusions observed in the southern part of the Dam area are referred to informally as "The Southern Granites" and require more detailed study. Their intrusive relationships to the Upper Silurian Wombat Creek Group indicates a probable Early Devonian age.

Tonalite at Taylors Crossing

A small elongate intrusion outcropping in the valley of the Mitta Mitta River near Taylors Crossing is a medium-grained grey tonalite comprising quartz, plagioclase, abundant biotite and some muscovite. Locally, it is foliated and contains randomly oriented micaceous xenoliths. It appears to intrude the Wombat Creek Group on the Mitta Mitta River, although the contact is not well exposed.

Granite on the Lower Tableland

A deeply weathered and poorly exposed intrusion in the Lower Tableland area, north of Benambra, has contact metamorphosed the Upper Silurian Wombat Creek Group. It is fine to medium grained granite containing perthitic orthoclase, oligoclase, quartz, biotite and pinitised cordierite (Crohn 1950) and some primary muscovite. Dykes associated with this intrusion outcrop along the Mitta Mitta River.

BANNIMBOOLA QUARTZ-DIORITE

Field Character

The Bannimboola Quartz-Diorite is exposed in an irregular shaped mass over 130 km² from Dartmouth to Granite Flat. A 1 km wide contact aureole has porphyroblasts of andalusite, cordierite, biotite and, within 20 m of the contact, sillimanite, overprinting regional chlorite-bearing slates. Near Dartmouth it intrudes the Dartmouth Granite. It is separated from the Dartella Volcanic Group by granitic rocks along Eight Mile Creek. In outcrop, the diorite is greenish-grey, lacks foliation and is generally homogeneous. It is often weathered, with large extremely tough, rounded tors in a

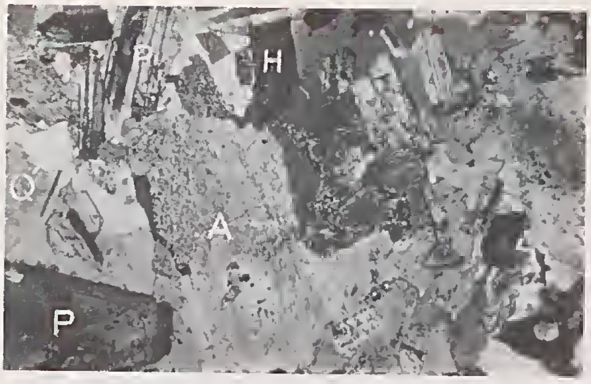


Fig. 10—Photomicrograph of Bannimboola Quartz-Diorite showing tabular augite (A), hornblende (H) and plagioclase (P) with interstitial quartz (Q). (×30)

residual feldspathic clay soil, although it does form rugged topography which reaches 1100 m at Granite Peak. Xenoliths up to 10 cm are locally abundant and commonly have diffuse boundaries. Most are amphibolitic with plagioclase-hornblende-clinopyroxene assemblages. Except within 1 m of its boundaries, the intrusion has no metasedimentary xenoliths.

Mineralogy and Chemistry

Grain size of the intrusion ranges from 1 mm to 3 mm. In thin section, it consists principally of subhedral plagioclase, hornblende, biotite and clinopyroxene phenocrysts (Fig. 10). Minor potash feldspar and quartz are interstitial. Scattered altered pinkish orthopyroxene anhedra are present in some sections. Sphene and apatite are accessory. In places, pigeonite is present. Modal analyses are presented below (Table 2). Several chemical analyses on the diorite have been carried out (Table 3) and a CIPW norm is shown for Analysis 1.

Points to note about these analyses include: a, relatively low SiO_2, K_2O relative to the Dartmouth Granite; b, abundant FeO, MnO, MgO, and Ca; c, $Na_2O > K_2O$ (except analysis 3). These chemical variations are reflected in the norm where diopside is present

TABLE 2
MODAL ANALYSES OF BANNIMBOOLA QUARTZ-DIORITE

	1	2	3
Quartz	13.5	12.5	10.0
Alkali Feldspar	21.5	5.0	8.0
Plagioclase	48.0	35.0	40.0
Hornblende	9.5	25.0	20.0
Clinopyroxene	4.5	12.5	11.5
Biotite	1.0	5.0	8.0
Orthopyroxene	—	3.0	1.5
Accessories	2.0	2.0	1.0

(1) GR 53984863 Benambra 1:100 000
(2) GR 54684894 Benambra 1:100 000
(3) GR 54504813 Benambra 1:100 000

TABLE 3
CHEMICAL ANALYSES AND CIPW NORM OF BANNIMBOOLA QUARTZ-DIORITE

	1	2	3
SiO_2	59.64	58.60	60.60
Al_2O_3	14.35	14.30	13.60
Fe_2O	3.17	6.70	6.20
FeO	4.18		
MnO	0.67	0.13	0.10
CaO	6.60	7.10	7.50
MgO	4.27	4.40	6.40
Na_2O	2.95	2.70	2.70
K_2O	2.14	2.40	2.80
H_2O^+	1.41	ND	ND
H_2O^-	0.24	ND	ND
TiO_2	0.71	0.60	0.50
P_2O_5	0.12	0.10	0.10
CO_2	*	ND	ND
	100.45	97.03	100.50
Quartz	14.44		
Orthoclase	12.68		
Albite	24.94		
Anorthite	19.54		
Diopside	10.06		
Hypersthene	10.93		
Magnetite	4.59		
Ilmenite	1.07		
Apatite	0.28		

(1) Bannimboola Quartz-diorite, Anal. R. Rogerson
(2) Bannimboola Quartz-diorite (Hesp 1974: 23)
(3) Bannimboola Quartz-diorite (Hesp 1974: 24)

and corundum absent. Hesp (1974) has reported high trace copper values (40 and 200 ppm) for this intrusion. The analyses above, and the presence of meta-basic (intermediate) cognate xenoliths in the intrusive, together classify it as an *I-type* granite (Chappell & White 1974).

Age

The Bannimboola Quartz-diorite has intruded the Dartmouth Granite and post-dates major regional ductile deformation of Ordovician metasediments. K/Ar age determinations on the pluton ranging between 399 ± 16 and 409 ± 16 m.y. (Richards & Singleton 1981), imply an Early Devonian cooling age for the diorite. This age is also significant as it suggests that the Dartella Volcanic Group and the diorite may be temporally related. Further chemical/isotopic work would be required to relate the diorite to the volcanics in a subvolcanic/volcanic sense.

GRANITE AT EIGHT MILE CREEK

A coarse-grained unfoliated, irregularly porphyritic granite outcrops occasionally on the Mitta Mitta River and in the Eight Mile Creek catchment area. It intrudes volcanics of the Dartella Volcanic Group (Bolger & Rogerson 1978b) at G.R.496519 but its boundary with the Bannimboola Quartz-Diorite is not exposed. Its

petrography has not been studied in detail. Where it intrudes the Sheevers Spur Rhyodacite it is a coarse grained plagioclase-quartz-potash feldspar-hornblende granodiorite. Chlorite occurs in patches and aggregates and may be replacing biotite. Fifty metres downstream from the Volcanics boundary, abundant medium-grained dioritic xenoliths occur. Adjacent to the Volcanics boundary, the granite contains accidental xenoliths of the Volcanics and occasional pyrite cubes. In the Eight Mile Creek catchment, this granite is rich in biotite and often lacks hornblende. The overall outcrop pattern, mineralogy and cognate xenolith population of this granite suggests it is similar to the Bannimboola Quartz-Diorite and they may be part of the same intrusive cycle.

The Granite at Eight Mile Creek shows many similarities to the Eustace Creek Granodiorite. Both of these bodies are highly complex intrusions which occupy similar structural settings marginal to the main volcanic belt of the Sheevers Spur Rhyodacite. They are poorly exposed, of variable grain size and texture and comprise a variety of rock types, all containing biotite and variable amounts of hornblende. However, the Eustace Creek Granodiorite on the east appears to be older as it is intruded by, and forms inclusions in, the Sheevers Spur Rhyodacite. In contrast, the Granite west of the Volcanic Belt at Eight Mile Creek contains clasts of the Volcanics and is a marginal intrusion. Foliation is also common in the Eustace Creek Granodiorite but was not observed in the western granite at Eight Mile Creek. Foliation alone as a criterion for distinction must be treated with caution as the foliation in the Eustace Creek Granodiorite may be related to its proximity to the roof of the intrusion.

Muscovite Granites

A fine to very coarse grained leucocratic muscovite granite covers wide areas near Eight Mile Creek and Eustace Creek. It is highly weathered, outcrops are rare, and the material available was unsuitable for thin section. In hand specimen, it appears to contain quartz-feldspar-muscovite and some tourmaline. It intrudes the Eustace Creek Granodiorite downstream from the mouth of Eustace Creek and the Sheevers Spur Rhyodacite near Larsen Hill. West of the volcanic belt the muscovite granite appears to intrude the Dartmouth Granite, the Bannimboola Quartz-Diorite and the granite at Eight Mile Creek.

Sub-volcanic Quartz Porphyries

There are a number of massive, pink quartz and quartz-feldspar prophyritic rocks exposed adjacent to the Wombat Creek Graben. A large massive body intrudes the Cravensville Formation in a creek north of Mount Benambra. Large dykes of similar composition intrude Ordovician metasediments along the Dart River upstream from Vincent Creek, and west of the Sheevers Spur Rhyodacite near Eight Mile Creek there is a poorly exposed quartz prophyry.

The intrusive relationships of all of these bodies are not clearly established but they are presumed to represent sub-volcanic rocks associated with the intrusion of the volcanics. Similar "granite porphyries" in the Gibbo River area to the south may have affinities with Siluro-Devonian volcanics in the Wombat Creek Graben rather than with the Triassic Mt. Leinster Complex which outcrops in the Benambra area to the south of the Dam.

DEFORMATION AND METAMORPHISM

Silurian Deformation

Metamorphism

The regional metamorphic rocks described above as medium and high grade Ordovician metasediments are schistose rocks occurring as aureoles around the Dartmouth Granite and Eustace Creek Granodiorite. This style of metamorphism is found throughout the Omeo and Wagga Metamorphic belts and results from the intrusion of granitic magmas during regional deformation. Cordierite and/or andalusite at medium grades, absence of kyanite and the incoming of alkali-feldspar soon after sillimanite in prograde metamorphism suggest the metamorphism was low pressure. Close association of granites and metamorphism implies the latter was Early Silurian in age.

Deformation

Detailed description of Ordovician metasediment deformation features is beyond the scope of this paper. Detailed descriptions and geometrical interpretation of Ordovician structures in this and surrounding areas are presented in Beavis and Beavis (1976), Rogerson (1976, 1979), Hellman (1976) and Fagan (1979). Two periods of regional ductile deformation occured in the map area (Rogerson 1979). The first, D_1, produced upright to steeply inclined non-plunging or shallow plunging tight to isoclinal mesoscale folds with a well developed subvertical axial plane slaty cleavage (S_1). Little is known of the strike of axial surfaces.

These folds were overprinted by upright 150° trending, plunging to reclined regional D_2 antiforms and synforms with an axial plane cleavage (crenulating S_1) developed in their hinge areas. The cleavage appears to be absent on fold limbs where strain occurred on S_1 cleavage planes. This second deformation led to rapid changes in younging and dip directions within Ordovician metasediments. Two contrasting D_2 fold styles are present in Ordovician metasediments separated on the map sheet by the Wombat Creek Graben. West of the Graben, the open to tight, steeply plunging (almost reclined) Callaghans Creek Synform (Rogerson 1979) occurs. On the Mitta Mitta-Dartmouth Road, D_1 mesofolds on the western limb of the D_2 synform are well developed. The regional synformal hinge area is traversed on the Dartmouth-Mt. Benambra Road. East of the Graben, no macrofolds of bedding have been described north of the Gibbo River. Isoclinal steeply plunging to reclined D_2 folds occur in this area so that most bedding and S_1 strike 150°. Ordovician metasediments strike easterly in the sedimentary corridor near Soldier Creek and in small areas along the Gibbo River.

Wombat Creek Group and Mitta Mitta Volcanics Deformation

The Wombat Creek Group is tightly to isoclinally folded on gently plunging to horizontal hinge lines trending 150° which are parallel to folds in adjacent low grade Ordovician metasediments. A vertical reticulate cleavage parallels fold hinge surfaces.

Folding of the Mitta Mitta Volcanics has been determined from the orientation of columnar joints and a tuffaceous sediment bed along the Mitta Mitta River. Dips are steep but younging directions are uncertain. A dip variation from steeply SW, near the confluence of the Gibbo and Mitta Mitta Rivers, to easterly near Italian Point, may be due to faulting, folding or a combination of both. General trends in the Mitta Mitta Volcanics parallel Wombat Creek Group trends. Deformation of Wombat Creek Group and the Mitta Mitta Volcanics is assigned to the Late Silurian to Early Devonian Bindian Deformation prior to extrusion of the Dartella Volcanic Group.

Dartella Volcanic Group Deformation

The Dartella Volcanic Group appears to be gently tilted or folded into broad open folds. Occasional dips, measured on eutaxitic foliation in the Sheevers Spur Rhyodacite, are generally less than 30°. The base of the Murtagh Creek Rhyolite in the Mt. Cravensville and Lightwood areas follows the topographic contours and suggests that the sequence is flat-lying. Adjacent to the margin of the Group, especially in the Cravensville Formation, some steep dips probably reflect movement on boundary faults. In the Dart River area, the attitude of the Dart River Volcanic Breccia varies widely and is complicated by widespread faulting.

Faults

The Wombat Creek Graben is bounded by major faults which were probably active during deposition of the Silurian to Devonian sequences in the Graben.

In the southern parts of the Graben, the Silurian Mitta Mitta Volcanics and Wombat Creek Group are bounded by the Wombat Creek and Morass Creek Faults which may have displacements greater than 3000 m. Near Limestone Gap, the Wombat Creek Fault has a wide crush zone, although further south the crush zone is absent and the fault is more difficult to locate. To the south, the Wombat Creek Fault is truncated by the Morass Creek Fault which continues southwards to Benambra. To the north, the Wombat Creek Fault appears to split into a number of faults juxtaposing the Mitta Mitta Volcanics and the Wombat Creek Group. The Morass Creek Fault continues to the north-west along Larsen Creek where contact metamorphic rocks of the Eustace Creek Granodiorite have been faulted out. Near Eustace Gap, it truncates the Soldier Creek Fault and forms the eastern boundary of the regional metamorphic zone along Eustace Creek.

Ordovician high grade metasediments are faulted against Mitta Mitta Volcanics by the east-west trending Soldier Creek Fault which forms the northern boundary of the Silurian sequence. Along the Mitta Mitta River, there is a 100 m wide crush zone and along the Eustace Gap Track, distorted slate and recrystallised volcanics occur in the fault zone.

Near Larsen Hill and Sheevers Point, the Sheevers Spur Rhyodacite and Ordovician metasediments are strongly distorted by the Larsen Hill Fault. Numerous fault planes can be seen in road cuttings. The Larsen Hill Fault forms the eastern boundary to the Rhyodacite along the Sassafras Gap Track. The eastern boundary of the Murtagh Creek Rhyolite is faulted against Ordovician metasediments by the Murtagh Creek Fault with much shearing of both volcanics and sediments. The Murtagh Creek Fault continues from the Glamour Hill Track to the junction of Shady Creek and the Dart River where the local structure is highly complex.

South of Mt. Benambra, a northeast to southwest trending belt of low grade Ordovician metasediments appears to be faulted against the Murtagh Creek Rhyolite and Sheevers Spur Rhyodacite on its southern side. The fault trends to the southwest towards the Mitta Mitta River but is not recognised at the river where there is an intrusive contact between the Sheevers Spur Rhyodacite and the granite near Eight Mile Creek. However, the distribution of younger intrusions and the linear nature of the western boundary of the Sheevers Spur Rhyodacite south of the river suggests that the boundary has been governed by a major structure which formed the margins of the Graben. Similarly, the western boundary of the Murtagh Creek Rhyolite and Cravensville Formation near Mount Tabor is considered to be faulted and movement on the fault has produced the steep dips in the Cravensville Formation.

The faulted boundary between the Murtagh Creek Rhyolite and Ordovician metasediments on the Dartmouth to Mt. Benambra Road is marked by the abundance of pegmatite veins. The fault trends northwest and follows the trend of the Morass Creek Fault beneath the Sheevers Spur Rhyodacite, although it has not been identified within the Rhyodacite. Faults and shear zones trending northwest to southeast are abundant at the Dam site in the Dartmouth Granite and the surrounding metamorphics. Major regional structures displacing regional metamorphic rocks in the north of the area are the Tallangatta Creek and Dribbling Creek Faults. They are recognisable over distances of tens of kilometres to the north but cannot be traced into the volcanic rocks of the Dartmouth area.

EARLY PALAEOZOIC GEOLOGICAL HISTORY

Deposition of terrigenous sediments in the Wagga Trough occurred from the Early to Late Ordovician. There is no record of Early Silurian sedimentation in this area although evidence from the Yalmy area to the east suggests that sedimentation continued uninterrupted from the Ordovician to the Early Silurian (VandenBerg *et al.* in press). Sometime in the Early Silurian, an event referred to as the Benambran Deformation produced intense deformation, metamorphism and generation of acid magmas, resulting in the forma-

tion of the Omeo Metamorphic Complex and its outlier at Dartmouth.

In the (?) Middle Silurian, the Wombat Creek Graben developed, initiating the extrusion of the Mitta Mitta Volcanics. The volcanism was followed by marine transgression and deposition of the Wombat Creek Group. Late Silurian to Early Devonian folding of the Silurian sequence was followed by acid to intermediate sub-aerial volcanism now preserved in the northern parts of the Graben as the Dartella Volcanic Group. Diorite, granodiorite and muscovite-bearing granitic rocks intruded the older metamorphic and igneous complexes. Mild tilting of the Dartella Volcanic Group took place in the Middle Devonian Tabberabberan Deformation. The margins of the Graben and attitudes of units within the Graben have subsequently been modified by faulting.

ACKNOWLEDGEMENTS

We wish to thank I. A. Nicholls, R. A. Cas, and O. P. Singleton for supervision of parts of the project and C. J. L. Wilson, S. D. Beams, A. H. M. VandenBerg, L. M. Chenoweth and J. R. Richards for discussion of aspects of the petrology, stratigraphy and structure of the area. W. D. Birch and the late D. T. Currey read and commented on the manuscript. This paper is published with the permission of the State Rivers and Water Supply Commission and the Director of the Geological Survey of Victoria.

REFERENCES

Beavis, F. C. & Beavis, J. H., 1976. Structural geology in the Kiewa region of the metamorphic complex, north-east Victoria. *Proc. R. Soc. Vict.* 88: 61-76.

Birch, W. D., 1978. Petrogenesis of some Palaeozoic rhyolites in Victoria. *J. geol. Soc. Aust.* 25: 75-87.

Bolger, P. F., 1978. New graptolite localities from north-eastern Victoria. *Rep. Geol. Surv. Vict.* 1978/44 (unpubl.).

Bolger, P. F., 1982. Ordovician and Silurian stratigraphy in the Wombat Creek-Benambra area, north east Victoria. *Proc. R. Soc. Vict.* 94: 35-47.

Bolger, P. F. & King, R. L., 1976. *Tallangatta 1:250 000 Geological Map.* Mines Department, Melb.

Bolger, P. F. & Rogerson, R. J., 1978a. *Cravensville 1:50 000 Geological Map.* Dept. Mins. and Energy, Melb.

Bolger, P. F. & Rogerson, R. J., 1978b. Observations, sections measured and specimens collected from the Dartmouth area, north-eastern Victoria. *Rep. Geol. Surv. Vict.* 1978/43 (unpubl.).

Brooks, C. & Leggo, M. D., 1972. The local chronology and regional implications of a Rb-Sr investigation of granitic rocks from the Corryong District, south-eastern Australia. *J. geol. Soc. Aust.* 19: 1-19.

Chappell, B. W. & White, A. J. R., 1974. Two constrasting granite types. *Pacific Geol.* 8: 173-174.

Cooper, B. J., 1977. Preliminary report on conodonts from the Wombat Creek Group, northeastern Victoria. S. Aust. Dept. of Mines Rept. 77/139 (Unpubl.).

Crohn, P. W., 1950. The geology, petrology and physiography of the Omeo District, Victoria. *Proc. R. Soc. Vict.* 62: 1-70.

Edwards, A. B. & Easton, J. G., 1938. The igneous rocks of north-eastern Benambra. *Proc. R. Soc. Vict.* 50: 69-96.

Fagan, R. K., 1979. Deformation, metamorphism and anatexis in an early Palaeozoic flysch sequence in north-eastern Victoria. Ph.D. Thesis, Univ. New England (unpubl.).

Hellman, P., 1976. Structural analysis of the Albury District, New South Wales. *J. Proc. R. Soc. N.S.W.* 109: 103-113.

Hesp, W. R., 1974. Geochemical features of Sn-Ta-Nb mineralisation associated with granitic rocks in south-eastern Australia. In *Metallisation Associated with Acid Magmatism*, M. Stemprock, ed., 1: 170-180.

Kilpatrick, D. J. & Fleming, P. D., 1980. Lower Ordovician sediments in the Wagga Trough—discovery of early Bendigonian Graptolites near Eskdale, north-east Victoria. *J. geol. Soc. Aust.* 27: 69-73.

Modrich, G., 1973. The geology and petrology of the Granite Peak Intrusive and its metamorphic aureole. B.Sc. (Hons.) Thesis, Univ. of Melb. (unpubl.).

Pogson, D. J. & Baker, C. J., 1974. Revised stratigraphic nomenclature for the Yass 1:100 000 Sheet. *Quart. Notes Geol. Surv. New South Wales.* 16: 7-9.

Richards, J. R. & Singleton, O. P., 1981. Palaeozoic Victoria, Australia—Igneous Rocks, Ages and their Interpretation. *J. geol. Soc. Aust.* 28: 395-421.

Ringwood, A. E., 1955. The geology of the Deddick-Wulgulmerang area, East Gippsland. *Proc. R. Soc. Vict.* 67: 19-66.

Rogerson, R. J., 1976. Metamorphism, folding and plutonism in the Wagga Metamorphic Belt of north-eastern Victoria. *Bull. Aust. Soc. Explor. Geophys.* 7: 41-43.

Rogerson, R. J., 1979. The early Palaeozoic metamorphic zones, plutonic Rocks of the Tallangatta-Dartmouth region, north-eastern Victoria. Ph.D. Thesis, Univ. of Sydney (unpubl.).

Singleton, O. P., 1965. Geology and Mineralisation of Victoria. In Geology of Australian Ore Deposits, J. McAndrew, ed. *Aust.I.M.M., Melbourne.* 440-449.

State Rivers and Water Supply Commission (SRWSC), 1980. Dartmouth Dam Geological Report, State Rivers and Water Supply Commission. 2 Vols., 321 pp.

Talent, J. A., 1959. Notes on middle Palaeozoic stratigraphy and diastrophism in eastern Victoria. *Min. Geol. J. Vict.* 6: 57-58.

Talent, J. A., 1965. The stratigraphic and diastrophic evolution of central and eastern Victoria in middle Palaeozoic times. *Proc. R. Soc. Vict.* 79: 179-195.

Talent, J. A., Berry, W. B. N., & Boucot, A. J., 1975. Correlation of the Silurian rocks of Australia, New Guinea and New Zealand. *Spec. Pap. geol. Soc. Amer.* 150: 1-108.

VandenBerg, A. H. M., 1978. The Tasman Fold Belt System in Victoria. *Tectonophysics.* 48: 267-297.

VandenBerg, A. H. M., Bolger, P. F., & O'Shea, P. J., (in press), Geology and mineral exploration of the Limestone Creek-Reedy Creek Area, north-east Victoria. *Rept. Geol. Surv. Vict.*